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09/856,212	05/18/2001	Kozo Nakamura	82821	6761

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EXAMINER	
SONG, MATTHEW J	
ART UNIT	**PAPER NUMBER**
1765	4

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Please find below and/or attached an Office communication concerning this application or proceeding.

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Office Action Summary	Application No.	Applicant(s)
	09/856,212	NAKAMURA ET AL.
	Examiner	**Art Unit**
	Matthew J Song	1765

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____ .

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☐ Claim(s) _____ is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 1-23 is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on 18 May 2001 is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☒ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Claim Rejections - 35 USC § 112

1. The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

2. Claims 5, 9-11, 16 and 23 are rejected under 35 U.S.C. 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention.

The specification does not set forth a method to produce a "perfect" crystal, one free of all defects and a prefect crystal is not shown. Applicants own definition of perfect crystal is unclear, as to if all or just the stated defects are removed. Applicants have shown a process to remove the stated defects but this does not teach one of ordinary skill in the art to remove all defects as the definition is open to include all defects. However, it is well settled in the Czochralski growth art that all crystals made with have some defect in it. The defects can range from point defects, lattice vacancies, strains and dislocations, note Chapter 5 of Zulehner and Huber. Therefore, applicant has not enabled the process for all dislocations and must show that the produced crystal is indeed "perfect" and free of any and all defects.

3. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

4. Claims 9-11 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. The use of quotes claims 9-11 is indefinite, it is unclear how the quotes limit the claims.

Claim Rejections - 35 USC § 102

5. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in-
> (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effect under this subsection of a national application published under section 122(b) only if the international application designating the United States was published under Article 21(2)(a) of such treaty in the English language; or
> (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that a patent shall not be deemed filed in the United States for the purposes of this subsection based on the filing of an international application filed under the treaty defined in section 351(a).

6. Claim 8 is rejected under 35 U.S.C. 102(e) as being anticipated by Kim et al (US 5,942,032).

Kim et al teaches a heat shield assembly for use in a crystal puller of the type used to grow monocrystalline silicon ingots according to the Czochralski method. Kim et al teaches a heat shield assembly (10) comprises an intermediate heat shield (40), a lower heat shield (42) and an upper heat shield (36) (col 5, ln 15-65) and the heat shield assembly can be raised and lowered using the existing pulling mechanism of the crystal puller (12) (col 3, ln 15-20). Kim et

al discloses the upper heat shield is positioned so that the portions of the ingot entering the upper heat shield are approximately at 1150°C and inside the upper heat shield, heat transfer from the ingot to the sidewalls is reduced so that the instantaneous axial temperature gradient G_0 is lessened in the portion of the upper heat shield (col 9, ln 40-50 and ln 25-27). Kim et al also discloses using the heat assembly (10), a high v/G_0 ratio is achieved and the ratio of v/G_0 is increased without changing the pull rate v, however variation in the pull rate may be employed to increase the v/G_0 ratio (col 9, ln 55-67 and col 10, ln 1-10).

7. Claims 14 and 17 are rejected under 35 U.S.C. 102(e) as being anticipated by Wijaranakula et al (US 5,827,367).

In a method for improving the mechanical stress of the neck section of a Czochralski silicon crystal, Wijaranakula et al teaches a cooling system (27) which creates a gaseous stream in a pull chamber (col 3, ln 57-60). Wijaranakula also teaches the neck section of the crystal ingot is shielded by a heat shield assembly from radiative heat transferred within the furnace and the heat shield assembly also provides a gas flow chamber for regulating the cooling gas flow through the neck section to keep the neck cool as possible, this reads on applicant's cooler (col 4, ln 55-65) Wijaranakula et al discloses the heat shield assembly is suspended and moved relative to and in conjunction with the movement of the seed chuck assembly and the heat shield assembly matches the extrusion of the neck, therefore the cooling gas is directed to the neck section by the gas flow chamber to cool the neck section (col 4, ln 65-67 and col 5, ln 1-6). Wijaranakula does not disclose the power consumption of the single crystal ingot production device is decreased by moving the cooler away from the solid-liquid interface between the single

crystal and the melt when a tail of the single crystal ingot is formed. It is inherent to Wijaranakula to decrease the power consumption by moving the cooler away from the solid-liquid interface between the single crystal and the melt when a tail of the single crystal ingot is formed because Wijaranakula teaches raising the cooler in conjunction with the movement of the seed chuck assembly, which is known to be moving away from the solid-liquid interface when the tail is being formed and because Wijaranakula teaches a similar cooler moving away from the solid-liquid interface, the power would inherently decrease.

8. Claims 14, 17 and 22 are rejected under 35 U.S.C. 102(e) as being anticipated by Shimanuki et al (US 5,900,059).

In a method of fabricating a semiconductor single crystal, Shimanuki et al discloses a shield cylinder having a plurality of telescopic ducts in order that he temperature gradient of the semiconductor single crystal can be reduced when it passes through the zone or region created when these ducts are lowered near the melt surface (col 5, ln 20-27) Shimanuki et al. teaches a wind-up reel (10) is driven to wind up the wire (8), then the third shield duct (6) is at first lifted, subsequently the second shield duct (5) and the first shield duct (4) are lifted in order and the shield ducts 4,5,6 become lapped with each other (col 4, ln 40-50) and a heater 16, which reads on applicant's furnace (col 1, ln 30-32). Shimanuki et al discloses the second shield duct and the third shield duct are lapped partly to form a cooling region, where the lapped portion corresponds to a specified portion of the single crystal silicon, this reads on applicant's limitation of cooler (col 5, ln 45-55). Shimanuki et al also discloses to form the tail, the wire is wound up and the up-down rods (3) are lifted after the temperature of the body drops below 1000°C, due to shield

ducts 4,5,6 surrounding the body, the body is cooled quickly, this reads on applicant's limitation of a size of a diameter of said single crystal ingot is adjusted by a distance of said cooler from a solid-liquid interface between said ingot and melt.

Referring to claim 14, Shimanuki et al also discloses to form the tail, the wire is wound up and the up-down rods (3) are lifted after the temperature of the body drops below 1000°C, due to shield ducts 4,5,6 surrounding the body, the body is cooled quickly, where shield ducts reads on applicant's cooler. This reads on applicant's limitation of moving said cooler away from the solid-liquid interface between the single crystal and the melt. Shimanuki is silent to the power consumption of the single crystal ingot production device is decreased by moving said cooler away from the solid-liquid interface between the melt and the crystal. It is inherent to Shimanuki to decrease the power consumption of the single crystal ingot production device because Shimanuki teaches a similar method of moving the cooler away from the solid-liquid interface between the single crystal and the melt as applicant when the tail is formed.

Referring to claim 17, Shimanuki et al also discloses to form the tail, the wire is wound up and the up-down rods (3) are lifted after the temperature of the body drops below 1000°C, due to shield ducts 4,5,6 surrounding the body, the body is cooled quickly, where shield ducts reads on applicant's cooler. This reads on applicant's limitation of moving said cooler away from the solid-liquid interface between the single crystal and the melt.

9. Claim 15 is rejected under 35 U.S.C. 102(e) as being anticipated by Kotooka et al. (US 6,036,776).

In a method of manufacturing single crystals by employing the Czochralski Method, Kotooka et al teaches melting the raw material fed into the crucible (8) (col 6, ln 55-60) and a single crystal ingot (7). Kotooka et al also teaches an after-cooler (31) is installed inside the heat shield plate in such a way that it can ascend and descend freely with the aid of the ascending/descending mechanism (32), therefore the heat shield plate and the after-cooler can be raised during the melting of the raw material (col 9, ln 30-52). Kotooka et al discloses the temperature gradient along the longitudinal axis of the single crystal also grows if the lower end of the after-cooler approaches the free surface of the melted liquid (col 9, ln 55-60). Kotooka et al also discloses if the heat shield plate is used together with an after-cooler, the single crystal lifting speed can be multiplied by a value of 1.1-2.5 (col 10, ln 40-45), this reads on applicant's limitation of a production time of a single crystal ingot is decreased. Kotooka et al also discloses the lifting speed of the single crystal can be raised by expediting the cooling of single crystal, which can be achieved by amplifying the temperature gradients in the longitudinal and the radial directions, especially in the region near the sold-liquid boundary (col 1, ln 40-45), this reads on applicant's limitation of cooling a predetermined location of a single crystal ingot being pulled. Kotooka also teaches the cooler in a lowered position inside the crucible (Figs 6 and 7)

Claim Rejections - 35 USC § 103

10. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

11. Claim 1 is rejected under 35 U.S.C. 103(a) as being unpatentable over Iida et al (US 5,968,264).

Iida et al teaches a single crystal ingot of silicon was pulled while varying the average pulling rate over a range of 1.0 mm/min and 0.4 mm/min. Iida et al also teaches the temperature gradient in an in-crystal descending temperature zone between a melting point of silicon and 1400°C in the vicinity of the solid-liquid interface was set as follows: G_e=45.0°C/cm and G_c=42.0 °C/cm, where G_e reads on applicant's G outer and G_c reads on applicant's G center. The ratio of G_e/G_c can be determined to 1.07 and at a pulling rate of 0.72 mm/min the V/G at the center is 0.16 mm^2/°C*min and at the outer periphery is 0.17 mm^2/°C*min (col 14, ln 20-67).

Iida does not teach temperature gradient in a pulling axis direction within a temperature range from silicon melting point to 1350°C. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Iida by attempting to optimize the temperature range by conducting routine experimentation.

Referring to claim 4, Iida et al is silent to a silicon wafer with decreased grown-in defects, which is obtained from the silicon ingot of claim 1. It is inherent to Iida's invention to produce a silicon wafer with decreased grown-in defects because Iida teaches similar growth conditions of a silicon single crystal ingot as applicant.

Referring to claim 5, Iida et al is silent to a silicon perfect single crystal wafer free from grown-in defects obtained from the silicon ingot of claim 1. It is inherent to Iida's invention to produce a silicon wafer with decreased grown-in defects because Iida teaches similar growth conditions of a silicon single crystal ingot as applicant.

12. Claim 2 is rejected under 35 U.S.C. 103(a) as being unpatentable over Iida et al (US 5,968,264) in view of Luter et al. (US 5,922,127).

Iida et al teaches all of the limitations of claim 2, except the conditions (a) and (b) of claim 1 are adjusted by changing a distance between a heat shielding element equipped in a Czochralski method-based silicon single crystal production device and silicon melt.

In an apparatus for pulling single crystals, Luter et al teaches a crucible mounted on a motorized turntable which raises the crucible to maintain the surface of the molten source material at a constant level as the ingot grows and the source material is removed from the melt (col 3, ln 60-65). Luter et al also teaches a heat shield (40) mounted above the upper surface of the molten source material (col 4, ln 32-37). Luter et al discloses the a heat shield may be positioned within the crucible above the melt for conserving heat at the interface between the ingot and molten material to prevent heat loss from the melt surface, which reduces the instantaneous axial thermal gradient G_0 (col 2, ln 15-25), therefore Luter reads on applicant's limitation of adjusting conditions by changing the distance between a heat shielding element and the silicon melt. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Iida et al with Luter to avoid undesired changes in the thermal profile during the growth process.

13. Claims 1 are rejected under 35 U.S.C. 103(a) as being unpatentable over Hourai et al (US 5,954,873).

Hourai et al teaches the relationship of V/G and the position in the radial direction of the crystal in Fig 2, where V is the single crystal pulling rate (mm/min) and the inside-crystal

temperature gradient in the direction of the pulling axis in a high temperature zone from the melting point of silicon to 1300°C. Hourai et al also teaches the single crystal pulling rate and the inside-crystal temperature gradient in the axial direction are two critical parameters for controlling the diameter of an oxidation-induced stacking fault (OSF) ring and the diameter of the OSF ring can be determined by the ratio of V/G (col 4, ln 50-60). Hourai discloses to compensate for changes in the temperature gradient of the crystal, the pulling rate is adjusted so that a constant V/G may be achieved (col 6, ln 55-60)

Hourai does not teach the parameter of a V/G=0.16-0.18 $mm^2/°C*min$ or a G outer/G center $\leq$ 1.10. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Hourai by deriving the condition of claim 1, based on the profile of Fig 2.

Hourai does not teach temperature gradient in a pulling axis direction within a temperature range from silicon melting point to 1350°C. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Hourai by attempting to optimize the temperature range by conducting routine experimentation.

Referring claim 3, Hourai discloses to compensate for changes in the temperature gradient of the crystal, the pulling rate is adjusted so that a constant V/G may be achieved (col 6, ln 55-60).

Referring to claim 4, Hourai et al is silent to a silicon wafer with decreased grown-in defects, which is obtained from the silicon ingot of claim 1. It is inherent to Iida's invention to produce a silicon wafer with decreased grown-in defects because Iida teaches similar growth conditions of a silicon single crystal ingot as applicant.

Referring to claim 5, Hourai et al is silent to a silicon perfect single crystal wafer free from grown-in defects obtained from the silicon ingot of claim 1. It is inherent to Iida's invention to produce a silicon wafer with decreased grown-in defects because Iida teaches similar growth conditions of a silicon single crystal ingot as applicant.

14. Claim 6 is rejected under 35 U.S.C. 103(a) as being unpatentable over Luter et al (US 5,922,127).

Luter et al teaches a crucible mounted on a motorized turntable, which raises the crucible to maintain the surface of the molten source material at a constant level as the ingot grows and the source material is removed from the melt for a crystal puller used to grow a monocrystalline ingot of the type used to manufacture semiconductor wafer (col 3, ln 50-67). Luter et al also teaches a heat shield (40) mounted above the upper surface of the molten source material (col 4, ln 32-37).

Luter et al is silent to a silicon single crystal ingot is produced while adjusting a distance between a heat shielding element and a silicon melt. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Luter et al by using a silicon source material because silicon is known in the art as material used to manufacture semiconductor wafers.

15. Claim 7 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kim et al. (US 5,942,032) in view of Luter (5,922,127).

Kim et al teaches a heat shield assembly for use in a crystal puller of the type used to grow monocrystalline silicon ingots according to the Czochralski method. Kim et al also teaches a crystal puller (12) includes a shell for isolating an interior, which includes a lower crystal growth chamber, this reads on applicant's limitation of a closed container. Kim et al discloses a quartz crucible containing a molten semiconductor source, where the crucible is mounted on a turntable for rotation about a vertical axis and is capable of being raised with the growth chamber. Kim et al also discloses heating panels (24) heat the crucible (col 4, 42-67). Kim et al also teaches the heat shield assembly an intermediate heat shield (40), a lower heat shield (42) and an upper heat shield (36) (col 5, ln 15-65) and the heat shield assembly can be raised and lowered using the existing pulling mechanism of the crystal puller (12) (col 3, ln 15-20). Kim et al discloses the upper heat shield is positioned so that the portions of the ingot entering the upper heat shield are approximately at 1150°C and inside the upper heat shield, heat transfer from the ingot to the sidewalls is reduced so that the instantaneous axial temperature gradient G_0 is lessened in the portion of the upper heat shield (col 9, ln 40-50 and ln 25-27). Kim et al also discloses the lower heat shield prevents heat from radiating from the sidewalls of the crucible to the ingot (col 9, ln 15-22). Kim et al also discloses using the heat assembly (10) a high v/G_0 ratio is achieved and the ratio of v/G_0 is increased without changing the pull rate v, however variation in the pull rate may be employed to increase the v/G_0 ratio (col 9, ln 55-67 and col 10, ln 1-10)

Kim et al does not teach a pulling element for pulling a silicon single crystal ingot, while rotating.

In a method of pulling a monocrystalline ingot used to manufacture semiconductor wafers, Luter et al discloses a pulling mechanism (30) rotates a seed crystal C and moves it up

and down through the growth chamber (col 4, ln 5-10). It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Kim with Luter because counter-rotating the crystal and crucible prevents the exchange of impurities between the melt directly below the crystal and the residual melt, note Chapter 2.5 of Zulehuler and Huber.

16. Claims 9-11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Adachi et al. (US 5,931,662).

Adachi et al teaches the preferred annealing conditions for forming defect-free region, where defect-free reads on applicant's perfect crystal, is to ramp up to a temperature in excess of 1100°C and annealing preformed at temperatures ranging from 500°C to 900°C for more than 10 minutes can provide IG functions by forming oxide precipitates, BMD. Adachi et al also teaches BMD for IG functions can also be formed by ramping up from 500°C to 900°C at a rate of 0.5°C/min (col 10, ln 60-67). Adachi et al discloses maintaining a temperature between 500°C to 900°C for more than 10 minutes during the ramp down process following sustained heating at a temperature in excess of 1100°C makes it possible to provide IG functions by forming BMD at a rate of 0.5°C/min (col 11, ln 5-15). Adachi et al also discloses silicon single crystal wafers were loaded into an annealing boat and into a furnace pre-heated to 700°C (col 11, ln 50-60). Adachi teaches in Fig 11 and 12 indicating the relationship between surface depth and oxygen concentration and the results indicate DZ layers had been secured in all wafers after annealing(col 12, ln 46-55)

Adachi et al does not teach a heat treatment temperature at the initial entry of the silicon single crystal wafer to be a target of the heat treatment is 500°C or less. It would have been

obvious to a person of ordinary skill in the art at the time of the invention to modify Adachi by attempting to optimize same by conducting routine experimentation.

Referring to claim 10, Adachi is silent to a uniform distribution of an oxide precipitate density of the silicon single crystal wafer after heat treatment. It is inherent to Adachi's invention to uniform the distribution of an oxide precipitate density of the silicon single crystal wafer after heat treatment because Adachi teaches a similar heat treatment with an ultimate temperature set in a range of 500-900°C at a similar ramping rate of 0.5 °C/min as applicant.

Referring to claim 11, Adachi is silent to adjusting the distribution of an oxide precipitate density of the silicon single crystal wafer after the heat treatment. It is inherent to Adachi's invention to uniform the distribution of an oxide precipitate density of the silicon single crystal wafer after heat treatment because Adachi teaches a similar heat treatment with an ultimate temperature set in a range of 700-900°C as applicant.

Referring to claim 12, Adachi teaches the oxygen concentration is less than 13×10^{17} atoms/cm^3 in the DZ layer in Figs 11 and 12. If Adachi does not teach this in Figs 11 and 12, then it would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Adachi by attempting to optimize same by conducting routine experimentation.

Referring to claim 13, Adachi teaches silicon wafers were annealed under similar conditions as taught by applicant.

17. Claims 14, 17, 21 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kotooka et al (US 6,036,776) in view of Shimanuki et al (US 5,900,059).

Kotooka et al teaches all of the limitations of claim 14, discussed above in claim 15, expect the power consumption of the single crystal ingot production device is decreased by moving said cooler away from the solid-liquid interface between the single crystal and the melt when a tail of a single crystal pulling ingot is formed.

In a method of fabricating a semiconductor single crystal, Shimanuki et al discloses a shield cylinder having a plurality of telescopic ducts in order that he temperature gradient of the semiconductor single crystal can be reduced when it passes through the zone or region created when these ducts are lowered near the melt surface (col 5, ln 20-27) Shimanuki et al. teaches a wind-up reel (10) is driven to wind up the wire (8), then the third shield duct (6) is at first lifted, subsequently the second shield duct (5) and the first shield duct (4) are lifted in order and the shield ducts 4,5,6 become lapped with each other (col 4, ln 40-50) and a heater 16, which reads on applicant's furnace (col 1, ln 30-32) Shimanuki et al discloses the second shield duct and the third shield duct are lapped partly to form a cooling region, where the lapped portion corresponds to a specified portion of the single crystal silicon, this reads on applicant's limitation of cooler. Shimanuki et al also discloses to form the tail, the wire is wound up and the up-down rods (3) are lifted, this reads on applicant's limitation of cooler is raised, after the temperature of the body drops below 1000°C, due to shield ducts 4,5,6 surrounding the body, the body is cooled quickly.

It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Kotooka et al with Shimanuki's method of forming the tail because body is cooled quickly reducing production time. It is inherent to the invention taught by the combination of Kotooka and Shimanuki to decrease the power consumption because the combination of Kotooka and Shimanuki teach a similar method of moving said cooler away from

the solid-liquid interface between the single crystal and the melt when the tail of said single crystal is formed.

Referring to claim 21, the combination of Kotooka et al and Shimanuki et al teaches all of the limitations of claim 21, except the cooler is lowered to cool the crucible for which heating is over after pulling said single crystal ingot out of said melt. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify the combination of Kotooka et al and Shimanuki et al by lowering the cooler to cool the crucible after pulling the single crystal ingot because it reduces the time needed to cool the crucible and a new growing process can be started more quickly.

18. Claim 16 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kotooka et al (US 6,036,776) in view of Hourai et al. (US 5,954,873).

Kotooka et al teaches all of the limitations of claim 16, as discussed above in claim 15, except said single crystal ingot includes a portion of a perfect crystal.

In a method manufacturing a silicon single crystal wafer, Hourai et al also teaches the single crystal pulling rate and the inside-crystal temperature gradient in the axial direction are two critical parameters for controlling the diameter of an oxidation-induced stacking fault (OSF) ring and the diameter of the OSF ring can be determined by the ratio of V/G (col 4, ln 50-60). Hourai et al also teaches as V, pulling velocity, is altered to slower pulling rates, the OSF ring develops at the intermediate position, a no-fault region is formed outside the ring, this reads on applicant's perfect crystal. It would have been obvious to a person of ordinary skill in the art at

the time of the invention to modify Kotooka et al with Hourai pulling velocity because it results in a single crystal ingot with fewer defects.

19. Claims 18-20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kotooka et al (US 6,036,776).

Kotooka et al teaches all of the limitations of claim 18, as discussed above in claim 15, except the cooler is lowered to cool the crucible for which heating is over after pulling said single crystal ingot out of said melt.

It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Kotooka to lower the cooler to cool the crucible after pulling said single crystal from said melt because it reduces the time needed to cool the crucible and a new growing process can be started more quickly.

Referring to claim 19, Kotooka et al teaches the cooler in a lowered position inside the crucible in Figs 6 and 7.

Referring to claim 20, Kotooka et al teaches all of the limitations of claim 20, as discussed above, except the crucible is raised to cool said crucible by moving said cooler and the crucible for which heating is over closer to each other after pulling said single crystal ingot out of said melt. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Kotooka by raising the crucible to move the cooler and crucible closer to each other after pulling said single crystal ingot out of the melt because it reduces the time needed to cool the crucible and a new growing process can be started more quickly.

20. Claim 23 is rejected under 35 U.S.C. 103(a) as being unpatentable over Wijaranakula et al (US 5,827,367) in view of Hourai et al (US 5,954,873).

Wijaranakula et al teaches all of the limitations of claim 23, as discussed above in claim 17, except said single crystal ingot includes a portion of a perfect crystal.

In a method manufacturing a silicon single crystal wafer, Hourai et al also teaches the single crystal pulling rate and the inside-crystal temperature gradient in the axial direction are two critical parameters for controlling the diameter of an oxidation-induced stacking fault (OSF) ring and the diameter of the OSF ring can be determined by the ratio of V/G (col 4, ln 50-60). Hourai et al also teaches as V, pulling velocity, is altered to slower pulling rates, the OSF ring develops at the intermediate position, a no-fault region is formed outside the ring, this reads on applicant's perfect crystal. It would have been obvious to a person of ordinary skill in the art at the time of the invention to modify Wijaranakula et al with Hourai pulling velocity because it results in a single crystal ingot with fewer defects.

Conclusion

21. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

Bihuniak et al (US 5,308,446) teaches as a single crystal is being pulled, the melt level of the crucible container also drops so that automatically controlled elevation of said crucible is commonly employed to avert undesired changes in the thermal profile during the growth process.

Bihuniak et al also teaches heat shields are employed to carefully control axial and radial temperatures in the melt. (col 1, ln 20-35)

Berthold et al (US 5,997,640) teaches a new growing process can be started after the growing crucible is cooled and refilled. (col 9, ln 7-15)

22. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Matthew J Song whose telephone number is 703-305-4953.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Benjamin L Utech can be reached on 703-308-3868. The fax phone numbers for the organization where this application or proceeding is assigned are 703-872-9310 for regular communications and 703-872-9311 for After Final communications.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0661.

mjs
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